The impact of AI on labor productivity and skill demand

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Abstract: This paper first expounds the relationship between labor productivity and artificial intelligence and explains the calculation formula. At the same time, according to the literature research and the calculation of China's agricultural, industrial and service labor productivity, it points out the reasons for the low level of China's current labor productivity. This paper makes an empirical analysis of how artificial intelligence affects labor productivity through the impact of industrial structure and employment structure by Using Stata software for causality test and OLS regression, and tries to find reasonable measures to improve labor productivity through the combination of empirical test and theoretical analysis. At the same time, combined with the perspective of the impact of China's industrial structure and employment structure on labor productivity under the premise of the era of artificial intelligence, this paper further summarizes the impact trend of artificial intelligence on labor productivity and puts forward countermeasures. This research is of great significance for improving China's labor productivity, enhancing the coordination between industrial structure and employment structure, and for the stable development of China's economy and society.

Key words: artificial intelligence; Labor productivity; Industrial structure; employment structure

1. Research background

In the era of artificial intelligence, technological progress will lead to destructive changes in employment, so we must improve the level of productivity to promote economic growth. China will develop the intelligent industry represented by artificial intelligence into one of the key industrial policies of the country. We must also seriously deal with the potential impact of artificial intelligence on the labor market. Therefore, it is important to conduct a comprehensive review of the impact of AI on the labor structure. China will become one of the world's major AI innovation centers. Since the existing literature mainly focuses on the impact of intelligence development in developing countries, this study provides new evidence for the impact of AI on labor productivity and skill demand. Although some literatures show that AI has a more important impact on low skilled labor, it shows that AI has a greater impact on developing countries, and more attention should be paid to the research in the academic field. At present, most of the relevant literature on how intelligence affects China's labor market is mainly qualitative research, while quantitative research is relatively lacking. Improving labor productivity has always been an important issue in the development and reform of various countries.

2. Model establishment

Firstly, according to the research goal, this paper establishes the relevant data analysis model, uses the regression method, and applies the ordinary least squares (OLS) estimation to study the impact of artificial intelligence on labor productivity. Considering the endogeneity of independent variables, this paper deals with AI variables with one-stage lag to further explore the impact of AI on labor productivity. Secondly, considering the substitution and promotion of AI, this paper selects employment structure and industrial structure as intermediary variables to study the impact mechanism of AI on labor productivity. Finally, this chapter makes statistics and explanations on the sources of the data, which lays a theoretical foundation for the empirical research later.

3. AI affects labor productivity by affecting industrial structure

This paper uses the test method proposed by Baron and Kenny (1986) to test the mediating effect. Usually, there are two kinds of mediation effects, one is the complete mediation effect, the other is the partial mediation effect.

C is the total effect of the independent variable on y, AB is the intermediary effect, and C 'is the direct effect. This paper uses the ratio of tertiary industry employees to all employees to represent the "employment structure" (JY).

According to the research object of this paper, the mediating effect model is constructed

Lap=c*int+e1 (model 1)

Jy=a*jy+e2 (model 2)

Lap=c '*int+b*jy+e3 (model 3)

At the same time, according to the bootstrap proposed by MacKinnon (1998), this paper tests the mediating effect of employment structure by bootstrap method (5000 samples).

The emergence of artificial intelligence has a more obvious impact on China's three industrial structures, which is reflected in the rapid growth of the output value of the tertiary industry and surpassing that of the secondary industry. AI promotes the change of industrial structure. Industrial upgrading means that backward production capacity is gradually replaced, and labor productivity changes. This paper tests the mediating effect of industrial structure by constructing the mediating effect model

Lap=c*int+e1 (model 4)

Cy=a*int+e2 (model 5)

Lap=c '*int+b*cy+e3 (Model 6)

At the same time, according to the bootstrap proposed by MacKinnon (1998), this paper tests the intermediary effect of industrial structure by bootstrap method (5000 samples).

4. Empirical analysis

According to the data from 2001 to 2019 and the regression analysis after standardized processing by SPSS software, it can be concluded that the main influencing factors of AI investment and the lag of China's labor productivity improvement are: first, the country's strong investment in new technology and the rapid development of AI technology. The fourth stage of stable development is from 2016 to 2017. China is deeply aware of the importance of AI development, and national policy support is being steadily implemented. Since 2017, AI technology has become more and more popular, and the government is increasingly focusing on the development of AI. Second, the promotion of new technologies will take some time. It takes time for a technology to come into being and use, for enterprises to accept it, and for employees to learn it. This has resulted in a certain lag in the production of new technologies and the improvement of labor productivity. The third is the cost consideration of the application of new technology. Some enterprises have given up the use of new technology in consideration of the cost of the use of new technology, which also leads to the lag in the improvement of labor productivity. Fourth, the level of education and human capital. The improvement of education level will greatly promote the production of high-tech talents and speed up the production of new technologies.

5. Regression analysis of partial mediating effect of employment structure

According to table 1 and table 2, in model 1, AI has a significant positive impact on total labor productivity; In model 2, AI has a significant positive impact on total labor productivity; In model 3, the significance of employment structure positively affects total labor productivity, indicating that there is a mediating effect, and AI significantly affects total labor productivity, indicating that the mediating effect is partial mediating effect. That is, artificial intelligence can directly affect the total labor productivity, and it can also affect the total labor productivity by affecting the employment structure.

Table 1 Summary of variables

index	Pronoun	dimension	Connotation and formula	data sources
Explained variable	Lap	Total labor productivity	GDP / annual average number of employees	China macroeconomic database
	LAP2	Labor productivity of secondary industry	Added value of secondary industry / average number of employees in secondary industry	China macroeconomic database
	Lap3	Labor productivity of tertiary industry	Added value of tertiary industry / average number of employees in tertiary industry	China macroeconomic database
Core explanatory variable	Int	AI patent application	Number of AI patent applications in the current year	2020 AI China Patent Technology Analysis Report
control variable	Tra	Foreign trade level	Proportion of foreign direct investment and total import and export	China Statistical Yearbook
	Hum	Human capital level	Proportion of industrial scientific and technological activity personnel in the total employment of the industry	China Statistical Yearbook
	Rdif	Input intensity of scientific research funds	Research and experimental development expenditure of scientific research and development institutions / GDP	China Statistical Yearbook
	Edu	Educational development level	Proportion of education expenditure in total financial expenditure	China Statistical Yearbook

Table 2 intermediary effect of employment structure

	(1) Lap	(2) JY	(3) Lap
Int	0.348***	0.076***	-1.026***
JY			0.427***
Observation	19	19	19
R-squared	0.9353	0.4875	0.9854
Adjr squared	0.9315	0.4574	0.9836

According to the bootstrap mediation effect test results, the coefficient of indirect effect is -0.0786, and the confidence interval is [-0.1184, -0.0268] excluding 0, indicating the existence of mediation effect; The coefficient of direct effect is 0.4268, and the confidence interval is [0.3946,0.4591], indicating that the mediating effect is partial mediating effect.

Table 3bootstrap mediation effect test

path	Indirect effect	Bootllci	Bootulci	Direct effect	Llci	ULCI
Artificial intelligence → employment structure → total labor productivity	-0.0786	-0.1184	-0.0268	0.4268	0.3946	0.4591

6□ Regression analysis of partial intermediary effect of industrial structure

According to table 4, in model 4, AI has a positive impact on total labor productivity; In model 5, AI has a significant negative impact on industrial structure. In model 6, industrial structure has a positive impact on total labor productivity, indicating that there is a mediating effect. AI has a positive impact on total labor productivity, indicating that the mediating effect is partial mediating effect.

Table 4 intermediary effect of industrial structure

	(4) Lap	(5) CY	(6) Lap
Int	0.348***	-.092***	0.519***
CY			1.863***
Observation			
R-squared	0.9353	0.8403	0.978
Adjr squared	0.9315	0.8309	0.9753

According to the bootstrap mediation effect test, the coefficient of indirect effect is -0.1707, and the confidence interval is [-0.2588, -0.1132] excluding 0, indicating the existence of mediation effect; The coefficient of direct effect is 0.5190, and the confidence interval is [0.4481,0.5898], indicating that the mediating effect is partial mediating effect.

Table 5 bootstrap mediation effect test

path	Indirect effect	Bootllci	Bootulci	Direct effect	Llci	ULCI
Artificial intelligence → industrial structure → total labor productivity	-0.1707	-0.2588	-0.1132	0.5190	0.4481	0.5898

7. Conclusion

In the future, with the rise of inflation rate, China's working age population will decrease, and labor prices will gradually rise in recent years. Therefore, China will face the double negative consequences of the decline of working age, and the population and labor costs will increase. This will cause labor productivity to hover at a low level. Therefore, China needs to take further measures to improve labor productivity by promoting the development of artificial intelligence. At present, artificial intelligence in the new era is mainly applied to the tertiary industry, which leads to the bottleneck of the development of China's secondary industry. The growth of labor productivity in the secondary industry is slow or even downward. In the future, we should gradually pay attention to the integration of artificial intelligence and the secondary industry.

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